receive each subset of the infrared light signals from the corresponding virtual light projector and redirect the subset of the infrared light signals to a target to form an illumination area on the target, the optical combiner including at least one infrared hologram that is responsive to infrared light and unresponsive to other light; and an infrared detector positioned and oriented to detect reflections of the infrared light signals redirected to the target area.

The eye tracking system according to the third aspect may further include one or more of the features described in C1 to C2 below.

C1: A second infrared hologram is positioned between the optical splitter and the optical combiner to apply a select optical function to at least a fraction of the infrared light signals outputted by the optical splitter. The second infrared hologram may have characteristics to apply a beam diverging function to the at least a fraction of the infrared light signals outputted by the optical splitter. Alternatively, the second infrared hologram may have characteristics to apply a beam converging function to the at least a fraction of the infrared light signals outputted by the optical splitter.

C2: A processor is communicatively coupled to the scanning light projector and the infrared detector and a non-transitory processor-readable storage medium that is communicatively coupled to the processor. The non-transitory processor-readable storage medium stores data and/or processor-executable instructions that, when executed by the processor, cause the eye tracking system to: generate infrared light signals by the infrared light source over a scan period; project the infrared light signals from the number M of virtual light projectors created by the optical splitter to the eye to form M illumination areas on the eye; detect reflections of the infrared light signals from the eye by the infrared detector for the scan period; and determine the gaze position of the eye in the target space from the detected reflections of the infrared light signals for the scan period.

In a fourth aspect, a wearable heads-up display may be summarized as including a support frame; a first scanning light projector including an infrared light source and at least one first scan mirror, the first scanning light projector to output infrared light signals according to a first scan pattern; a first optical splitter having a number M>1 of optical elements, each of the number M of optical elements to receive a subset of the infrared light signals outputted by the first scanning light projector and create a virtual light projector for the subset of the infrared light signals; a first optical combiner positioned and oriented to receive each subset of the infrared light signals from the corresponding virtual light projector and redirect the subset of the infrared light signals to a target to form an illumination area on the target, the first optical combiner including at least one infrared hologram that is responsive to infrared light and unresponsive to visible light; a second scanning light projector including a plurality of visible light sources and at least one second scan mirror, the second scanning light projector to output visible light signals according to a second scan pattern; a second optical splitter having a number N>1 of optical elements, each of the number N of optical elements to receive a subset of the visible light signals outputted by the second scanning light projector and create a virtual light projector for the subset of the visible light signals; a second optical combiner positioned and oriented to receive each subset of the visible light signals from the corresponding virtual light projector and redirect the subset of the visible light signals to the number N of exit pupils proximate the target, the second optical combiner including at least one visible hologram that is responsive to visible light and unresponsive to infrared light; and an infrared detector coupled to the support frame to detect reflections of the infrared light signals from the target.

In a fifth aspect, A wearable heads-up display may be summarized as including a support frame; a scanning light projector including an infrared light source, a plurality of visible light sources, and at least one first scan mirror, the scanning light projector to output infrared light signals and visible light signals; an optical splitter having a number M>1 of optical elements, each of the number M of optical elements to receive a subset of the infrared light signals and a subset of the visible light signals outputted by the scanning light projector and create a virtual light projector for the subset of the infrared light signals and the subset visible light signals; an optical combiner lens positioned and oriented to receive each subset of the infrared light signals and each subset of the visible light signals, the optical combiner lens comprising a first optical combiner to redirect each subset of the infrared light signals to form one of the number M of illumination areas on a target and a second optical combiner to redirect each subset of the visible light signals to one of the number M of exit pupils proximate the target; and an infrared detector coupled to the support frame to detect reflections of the infrared light signals from the target.

The foregoing general description and the following detailed description are exemplary of the invention and are intended to provide an overview or framework for understanding the nature of the invention as it is claimed. The accompanying drawings are included to provide further understanding of the invention and are incorporated in and constitute part of this specification. The drawings illustrate various embodiments of the invention and together with the description serve to explain the principles and operation of the invention.

BRIEF DESCRIPTION OF DRAWINGS

In the drawings, identical reference numbers identify similar elements or acts. The sizes and relative positions of elements in the drawings are not necessarily drawn to scale. For example, the shapes of various elements and angles are not necessarily drawn to scale, and some of these elements are arbitrarily enlarged and positioned to improve drawing legibility. Further, the particular shapes of the elements as drawn are not necessarily intended to convey any information regarding the actual shape of the particular elements and have been solely selected for ease of recognition in the drawing.

FIG. **1** is a schematic diagram of an eye tracking system.

FIG. **2** is a schematic diagram of an eye and illumination areas projected onto the eye.

FIG. **3**A is an isometric view of an optical splitter.

FIG. **3**B is an isometric view of an optical splitter including an infrared hologram with an optical function.

FIG. **3**C is an isometric view of an optical splitter including two infrared holograms with optical functions.

FIG. **4**A is a diagram of a scan space and illustration of drawing a raster pattern in the scan space.

FIG. **4**B is a diagram showing facets of an optical splitter on a plane and the scan space of FIG. **4**A superimposed on the facets.

FIG. **4**C is a diagram showing illumination areas corresponding to the facets and scan space of FIG. **4**B.

FIG. **4**D is a diagram showing forward and reverse scanning of a glint.

FIG. **5** is a schematic diagram showing detection of reflections of infrared light from an eye along multiple paths.